

POTENTIAL USE OF SPLIT-BEAM ECHOSOUNDER ANGULAR INFORMATION FOR BIVALVE BANKS CARTOGRAPHY: A CRITICAL EVALUATION

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INTRODUCTION

Acoustic methods have been recently used for the direct observation of mollusk reefs [1-3] providing information about their spatial distribution.

Among the current acoustic technologies are split-beam echosounders that detect phase differences, interpreted as athwartship and alongship angles [4], thus allowing the triangulation of point-like scatterers [5] or the assessment of the motion of a fish school [6]. These angular measurements over extended objects, such as the sea bottom, could be used to detect the inhomogeneities in the sediment.

The main objective of this study is to assess whether split-beam technology may provide information on the density of buried bivalve mollusks. Due to their differentiated shape (and thus, expected acoustic signature), we will focus our study in the mapping of razor shell banks.

MATERIALS AND METHODS

Study Area

The study was performed in the Ría de Pontevedra (Galicia, NW Spain). Three razor banks, regularly exploited by divers (they are located between 5-11 meters deep), were considered for this study: Raxó, Agüete and A Cova. Attending to their razor harvesting density at the time of the survey, these banks were characterized as very productive (Raxó), productive (Agüete), or non productive (A Cova).

Acoustic Survey

Fourteen acoustic transects parallel to the coast were recorded along the banks. A Simrad EK60 scientific echosounder with an ES200-7C split-beam transducer was attached to the hull rail of a small fishing boat. The transducer was set to work at 200 kHz and minimum pulse length (64 μ s) and at a sampling frequency of 10 pings/s. Weather conditions were good and the boat speed was kept between 2.5 and 4.2 knots.

Groundtruthing

In order to validate the acoustic classification, 2 stations were set per bank. Sediment samples were collected with a 30 cm corer, and biological communities were characterized using a suction pump with a mesh size of 1 cm. All these data were found to be in agreement with fishermen harvesting information.

Split-beam Texture Analysis

A second order statistical procedure, aimed at detecting correlations between nearby acoustic samples, is textural analysis based on the symmetric co-occurrence matrix [7], usually defined along a given direction of the data matrix: we will take this direction along the pings of the angular echogram. Haralick [8] introduced a set of textural features that (together with lacunarity) have been calculated for the first 30 cm of sediment signal for each transect of the survey.

Statistical Analysis

A hierarchical agglomerative cluster analysis was performed on the transects to classify them by banks. To account for the spatial distribution a further classification was performed dividing the transects in four segments each. To reduce the dimensionality, prior to clustering, PCA analysis was performed, keeping only those components with eigenvalues larger than 1 (Kaiser's rule). Furthermore, all the statistical treatment was repeated twice considering only transects and segments leaving the coast to portboard or starboard, respectively.

The pitch and roll motions of the vessel were not mechanically compensated during the survey. To address the influence of these motions on the result, two kinematic variables, the speed and the pitch and roll motion amplitude (inferred from the reflected intensity variance) were computed around each ping. Then

the same statistical analysis (PCA and hierarchical clustering) was applied to these data, in order to highlight any resemblances to the angular classification.

RESULTS AND DISCUSSION

The statistical analysis of the transects, based on textural features, results in a dendrogram showing three main branches, one formed by two Raxó transects and the other two further subdivided in two subbranches, one corresponding to Agüete, and the others to Raxó and A Cova. When the course is taken into account, the coast-to-starboard dendrogram groups all the transects by banks. The dendrogram of the textural features of the segments shows four main branches: Raxó, Agüete, A Cova, and the remaining one further divides in four sub-branches two with Agüete and the other two with Raxó and A Cova. Again, separation by courses, improves the grouping of the segments by banks.

The two halves of the Agüete bank are differently grouped. The other two banks, do not show this spatial segregation. This is in accordance with the ground-truthing data of razor density. Neither the distribution of the segments comprised in the branches mixing different banks, nor the distance between neighbour branches can be explained by granulometric data or razor densities alone. The dendrogram obtained from the kinematic variables mostly separates the three banks, as did the angular textures, a result that cannot be achieved using one single kinematic variable. However, the classification has more "misplaced" segments, and lacks any hint of inhomogeneity in Agüete.

CONCLUSIONS

This work has shown that split-beam echosounder angular signal provides information about the sediment characteristics that can render a seafloor classification. However kinematic variables have been shown to be correlated with part of that information too.

In this sense, the compensation of the ship motion at acquisition time is imperative in order to make the most of the acoustic angular data, even when weather conditions are good and vessel speed is kept almost constant.

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